there have been two specialists, each charged with investigations similar in character. Finally, the appointment of an Inspector General of Agriculture adds to the staff an official with a close interest in all the branches of science which bear upon the agricultural conditions of the country.

(5) The subject has received the careful consideration of the Governor General in Council, and he has arrived at the conclusion that a central authority is needed to ensure that the work of scientific research is distributed to the best advantage, that each investigator confines his researches to the subject with which he is most capable of dealing, and that energy is not dissipated by the useless duplication of inquiries or misdirected by a lack of inter-departmental cooperation. The various departments of science are not self-contained, but closely interlinked. Agriculture needs the aid of botany, botany the assistance of geology, geology of chemistry, and an endeavour should be made to combine the different departments in a system of mutual assistance. The Governor General in Council has no wish to imply that there has been any disposition on the part of one department to hold itself aloof from another. But the institution of an authorised scheme of mutual assistance will result in a closer cooperation for the purposes of effective research than has been possible in the past.

(6) A further reason exists for the constitution of a central advisory authority. Though greater prominence has been given in recent years to the practical or economic side of inquiry, its importance is not even yet always adequately recognised. The Government of India fully realise the great value of the work effected in the past by their scientific departments, in the shape of scientific exploration and systematic work, and they recognise that such inquiries must necessarily precede any attempt towards the solution of more practical problems. But in those departments there has been a not unnatural tendency to give the claims of abstract science precedence over the more practically important demands of economic or applied science. In making these remarks, the Governor General in Council has no desire to underrate the importance of original research for purely scientific objects, or to assert that the practical application of science should be the sole aim of technical departments. It is his wish that the high reputation which has been gained by more than one branch of scientific work in India should be maintained, and that the Indian departments should retain touch with scientific progress in Europe and America. But in view of the fact that the Indian Government own the largest landed estate in the world, that the prosperity of the country is at present mainly dependent upon agriculture, that its economic and industrial resources have been very imperfectly explored, and that the funds available for scientific work are limited, the importance of practical research is preeminent, and a central authority, which can speak with knowledge upon scientific questions, will be in a position to enforce the repeated declarations of the Government of India on the subject.

(7) The Governor General in Council proposes therefore to constitute a Board of Scientific Advice comprising the heads of the Meteorological, Geological, Botanical, Forest, Survey, Agricultural, and Veterinary Departments, together with such other scientific authorities as may from time to time be invited by the Government of India to serve upon it. These latter will include scientific officers in the service of the Imperial and Provincial Governments whose special attainments render their assistance desirable. The Government of India hope that the Trustees of the Indian Museum, who, as custodians of the national scientific collections, have always shown an active interest in the prosecution of scientific work, will associate themselves with the scheme, and they will be addressed separately on the subject. The Secretary to the Government of India in the Department of Revenue and Agriculture, to which the scientific departments concerned are administratively subordinate, will be *ex-officio* President of the Board, and the Secretary to the Board will be selected, subject to the approval of Government, by the Board from amongst its members. The Board will review and advise generally upon the operations of the departments, with due attention to the economic side of their work, and will serve as a referee in all matters connected with the organisation of scientific inquiry in this country. It will annually receive and discuss the proposals of each departmental head in regard to the programme for investigation in his department. In cases where inter-departmental cooperation is necessary, it will rest with the Board to advise as to the lines on which mutual assistance should be given and the department to which the inquiry should primarily appertain. Where the proposed investigation falls exclusively within the domain of a particular department, the function of the Board will be confined to examining and criticising the proposals. It is not intended that the directing influence of the Board should in any way weaken departmental executive control or responsibility, and the precise manner in which, and the agency by which, any required information is to be collected or investigation carried out must be left to the heads of the departments concerned.

(8) The Board will submit annually to Government a general programme of research which will embody the proposals of departmental heads in so far as its subjects are to be exclusively dealt with in one department, and its own proposals in cases where two or more departments are to cooperate. At the end of the year it will submit to Government a brief review of the results obtained in all lines of scientific investigation, based upon the annual departmental reports and upon any papers published by individuals. Generally, the Board will act as an advisory committee to the Government of India and as an intermediary between the Government of India and their scientific officers in respect of all questions of technical research which are dealt with in the Department of Revenue and Agriculture. The Royal Society have already been good enough to offer their aid in furthering scientific work in India, and their invaluable advice and assistance will be freely invoked by the Board now constituted.

(9) To enable the Board to carry out the duties which are assigned to it, the Governor General in Council considers it desirable that its members should meet as a collective body at stated intervals for the purposes of discussion. It will probably be ordinarily sufficient to hold two meetings a year; one to consider the work of the past year and proposals for the programme of the coming year in each department; the other to settle finally those programmes subject to the approval of Government. The most convenient dates for holding these meetings will be settled in consultation with the Board.

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(1) The Surveyor General of India.
(2) The Inspector General of Forests.
(3) The Director, Geological Survey of India.
(4) The Meteorological Reporter to the Government of India and Director General of Indian Observatories.
(5) The Inspector General, Civil Veterinary Department.
(6) The Director, Botanical Survey of India.
(7) The Reporter on Economic Products to the Government of India.
(8) The Inspector General of Agriculture in India.
(9) The Director General of Archæology in India.
(10) The Chief Inspector of Mines in India.

(10) Ordered, that the Resolution be communicated to all Departments of the Government of India and Local Governments and Administrations for information and to the Departments above noted for information and guidance; and that it be published in the Supplement to the *Gazette of India.*

SOLAR PROMINENCE AND SPOT CIRCULATION, 1872–1901.[1]

IN previous numbers of this Journal (vol. lxvi. p. 248, and vol. lxvii. pp. 224 and 377) references have been made to the connection between solar, meteorological and magnetic changes, and some of the results obtained from a reduction of the solar prominences as observed by Prof. Tacchini at Rome were described.

[1] Abstract of a paper recently read before the Royal Society by Sir Norman Lockyer, K.C.B., F.R.S., and William J. S. Lockyer, M.A., Ph.D., F.R.A.S.

The result of the discussion showed that the curve representing the variation of percentage frequency of the prominences for the whole limb of the sun indicated that in addition to the main epochs of maxima and minima coinciding in time generally with those of the maxima and minima of the total spotted area, there were also prominent subsidiary maxima and minima.

Further, dividing the sun's limb into zones of 20° in width from the equator, with a pole zone of 10°, and discussing each zone separately, the variation of the prominence percentage frequency about the equator was found to be very different from that in the higher latitudes, the former changing with the spots, and the latter exhibiting sudden outbursts just previous to the epochs of sunspot maxima, followed and preceded by comparatively long intervals of quietude.

In the present investigation the prominence observations have been discussed from a different point of view, in order to trace out, if possible, the heliographic latitudes of the chief centres of action of prominence disturbance, or in other words, to indicate the regions on the solar disc where prominences were most prevalent in each year, and see if those regions varied their positions in relation to the sun's equator.

In this way it could be determined whether such movements, if any, are subject to some periodic law, in which case it would be possible to increase our knowledge of the circulation of the solar atmosphere in regions outside those in which sunspots alone have, up to the present, been employed.

It has long been known that the centres of action of sunspot disturbances, as shown by Carrington, Spoerer and others, are restricted to particular regions on the solar surface, all of which are included in the two large zones from $\pm 5°$ to $\pm 35°$ heliographic latitude. Further, from year to year, the regions of greatest activity undergo changes of position which are periodic. Thus at sunspot maximum there is only one zone in each hemisphere in which spots are situated, the centre of this being about 18° N. and S., while at minimum there are two zones existing simultaneously in each hemisphere; the older cycle dying out in the zone the centre of which was situated in low latitudes, and the new one commencing in high latitudes, its centre being about latitude $\pm 30°$ to $\pm 35°$.

It may be here remarked that the above results are not strictly, but only generally, true, because the observations of each solar hemisphere have not been treated sufficiently in detail. If this be done by examining the behaviour of the frequency or areas of spots in, say, zones of 5° in width, then it will be found that sometimes there are actually three centres of spot activity. The reduction of sunspots in this manner for the whole period, since accurate measurements have been made, is not yet complete, but it is as well to draw the reader's attention to these facts.

Fortunately, the investigator has at his disposal two splendid series of observations of prominences made independently of each other, so that he is able to check the variations indicated in one series by seeing if they are exhibited in the other.

The observations thus discussed were made by Tacchini at Rome from 1872–1900, and by Ricco and Mascari at Catania from 1881 to 1901. Both sets of observations are handled in exactly the same way, and it will be seen later that the changes indicated in each are practically identical. It is due to the kindness of Prof. Ricco, who forwarded some unpublished data concerning his prominence observations and deductions, that the curves are complete up to the end of the year 1901.

The method of reduction adopted was to determine for each year the percentage frequency of prominence activity for every 10 degrees of solar latitude north and south. A series of curves was next drawn, one for each year, the abscissæ representing the latitudes of prominences north and south, and the ordinates their percentage frequency. It was then found that the centres of prominence activity, or in other words, the maxima of the curves were sometimes single, sometimes double, and in one or two cases even triple in each hemisphere. This suggested that just as sometimes there are two zones of spots existing at one time, so there might be one, two, or occasionally three zones of prominences in existence in each hemisphere simultaneously.

Further, a close examination of the whole set of curves with reference to these points of maxima made it possible not only to study the changes of latitude of these points from year to year, and their positions when commencing to develop or about to disappear, but the intensity of these centres in relation to each other.

The accompanying illustration (Fig. 1) shows the curves drawn for the years 1879, 1880, and 1881, from the observations of Tacchini, and serves as examples of the curves that have been discussed; they exhibit the change from a single to a double centre of activity in each hemisphere.

Thus, in 1879, there was a prominence maximum in each hemisphere at latitudes $\pm 50°$. In the next year (1880), both these maxima had retreated further away from the equator, namely to latitudes $\pm 60°$, while another centre of disturbance began to make itself apparent at latitudes $\pm 30°$. In the year 1881, both centres in each hemisphere were strongly marked and became of about the same intensity, their mean latitudes in each hemisphere being about $\pm 30°$ and $\pm 60°$. These curves thus indicate that during these three years, the direction of motion of these centres of activity tends polewards or away from the equator.

By examining both series of observations made by Tacchini and Ricco and Mascari, and analysing the positions of the principal and subsidiary maxima for the whole

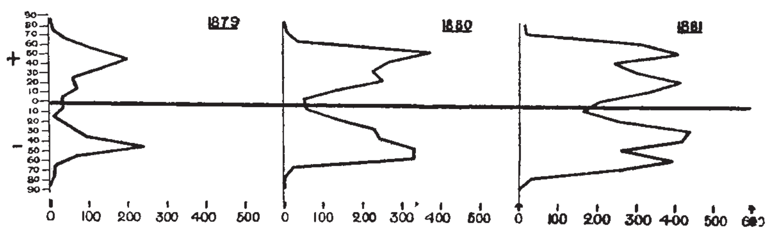

FIG. 1.—Curves illustrating the percentage frequency of solar prominences for each 10 degrees of heliocentric latitude for the years 1879, 1880 and 1881: after the observations of Tacchini.

period covered by the observations, the results illustrated graphically in Fig. 2 were obtained.

In these figures the facts are brought together for each hemisphere separately. The medials of the lines (curves A and B) show the heliographic latitudes of the centres of prominence action; the thickness of these lines represents the relative percentage frequency of prominence action.

For the sake of comparison, three other curves for each hemisphere are shown. The first curves (C) show the mean heliographic latitude of spotted area for each hemisphere; these curves, as previously pointed out, are only generally accurate. The next curves (D) illustrate the variations of the percentage frequency of prominence action for each hemisphere taken as a whole, and are similar to those given previously.

The last curves (E) show the variation of the mean daily area of sunspots from year to year, also for each hemisphere.

With this diagram the reader will be able at once to compare the variations of the changes of latitude of prominences as determined from the Roman and Sicilian observations. He will also be able at a glance to correlate these variations with those exhibited in the other curves added for comparison. It will therefore suffice if a summary of the conclusions drawn be given.

(1) The centres of action of prominence activity undergo an apparently regular variation.

(2) The direction of motion of these centres is from low to high latitudes, the reverse of that of spots, which travel from high to low latitudes.

This is seen directly from the curves, the prominences beginning in about latitude $\pm 20°$, and moving away from

the equator until they terminate in latitude $\pm 80°$. The general trend of the spots is from latitude $\pm 35°$ to $\pm 5°$.

(3) At epochs of prominence minima (which are concurrent with sunspot minima) these centres of action are

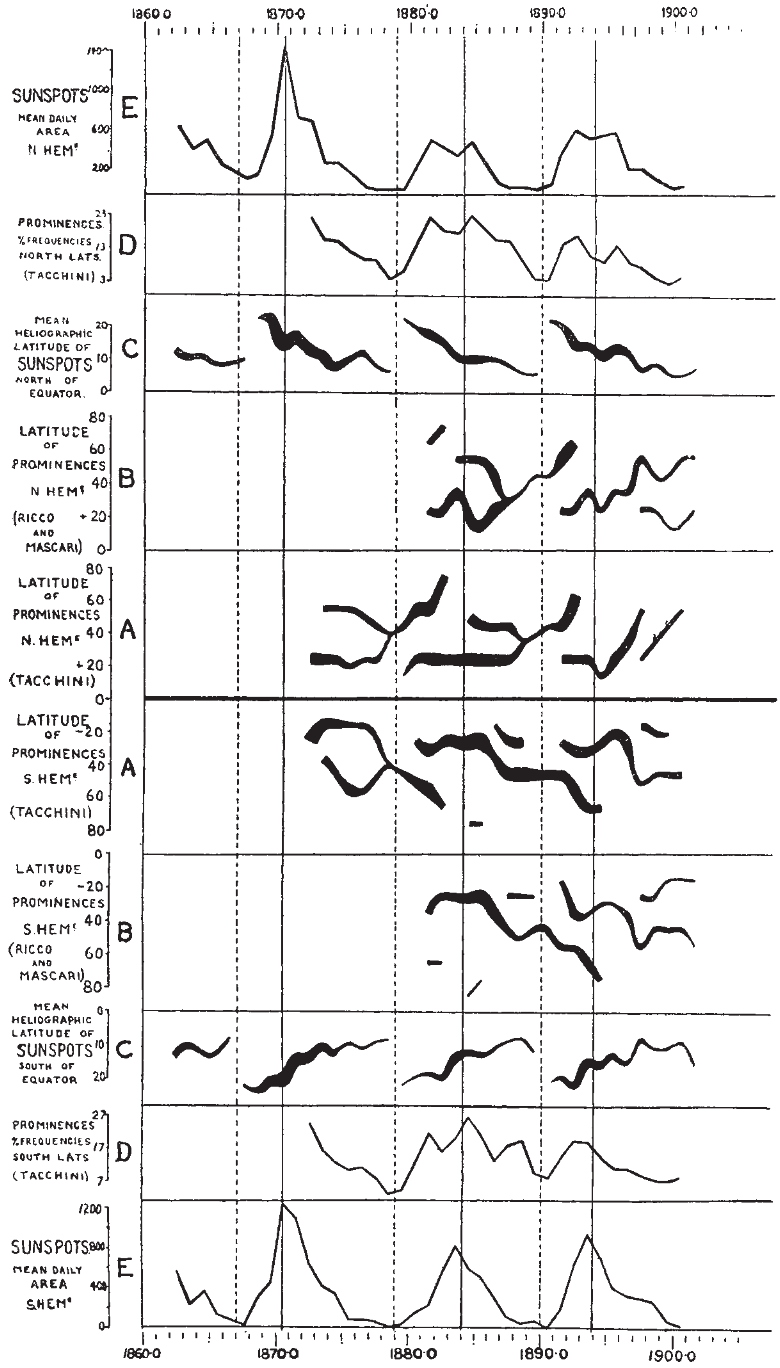

FIG. 2.—A comparison of curves illustrating the variations of the positions the centres of action of prominences (A and B) and spots (C), the percentage frequency of prominences (D), and the variation of spotted area (E). (The continuous and broken vertical lines indicate the epochs of sunspot maxima and minima respectively, the two hemispheres being taken together.)

restricted to one zone (about latitude $\pm 44°$) in each hemisphere, while those of the spots occupy two zones in each hemisphere.

Since the broken vertical lines in Fig. 2 represent the epochs of prominence and spot minima, it will be seen that these cut curves C when two zones of spots are in evidence, and intersect the curves A and B when there are only single zones of prominences.

(4) At nearly all other times these centres are apparent in two zones, while those of the spots occupy only one in each hemisphere.

This deduction is true if the curves C be taken as representing simply the phenomenon generally, but it should be borne in mind, as stated previously, that a new reduction of these spot zones, which is in hand, is necessary.

(5) The subsidiary maxima exhibited by the curves representing the percentage frequency of prominence activity for each entire hemisphere are due to the presence of two well-developed centres of prominence activity in each hemisphere.

To make the comparison the subsidiary peaks on the curves D should be compared with the curves A and B, and in every case the former are accompanied by two zones of prominences.

Before concluding this article it may be mentioned that other observers, and among them Father A. Fényi, S.J., have studied this question of prominence distribution, but their discussions have been restricted to only comparatively short intervals of a few years; their results are, however, in harmony with those described here.

It is important finally to state that the deductions here made may be partially incomplete owing to the difficulty of determining sometimes whether a new centre of action has been formed or the position of an old one changed. Further, account must be taken of the fact that the material discussed does not represent the record of the percentage frequency of prominences determined from observations made on the disc of the sun (now rendered possible by the Jannsen-Hale-Deslandres method), but one obtained from observations of the phenomena occurring only at the limb of the sun. The close agreement between the observations of the different observers shows nevertheless that this latter method is of great value.

WILLIAM J. S. LOCKYER.

THE STATOLITH THEORY OF GEOTROPISM.[1]

THE paper deals with the modern theory[2] of the mechanism by which plants are enabled to regulate their line of growth by means of the force of gravity. When an upright flower-stalk is forcibly subjected to a change of position, for instance by laying the flowerpot on its side, it responds by geotropic curvature, and finally regains the vertical. The statolith theory is not concerned with the mechanism of curvature, but merely with the question how horizontality can originate a stimulus, in other words, how the plant perceives that it is no longer vertical. It is known that in some animals, for example the Crustacean Palæmon, the faculty of spacial orientation depends on statoliths (otoliths) which serve as guides by pressure on the internal surface of the otocyst. This theory has now been applied

[1] A paper by Mr. Francis Darwin, read at the Royal Society, March 12.

[2] Published simultaneously by Haberlandt and Němec in vol. xviii. of the *Berichte d. Deutschen Bot. Gesell.*; see also *Pringsheim's Jahrb.*, vols. xxxvi., xxxviii.